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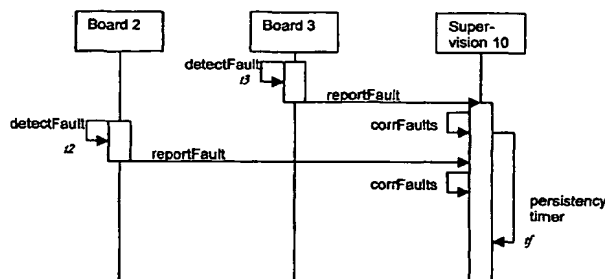
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[Continued on next page]

(54) Title: SYSTEMS FOR PROTECTION LINK SUPERVISION



Note: *t2, t3* and *tf* are event IDs to be referred by timing analysis.

(57) Abstract: The invention relates to a system for protection link fault supervision between two nodes (1, 11) in a transmission network. The nodes (1, 11) are connected by first (6) and second (8) transmission lines carrying identical data traffic between the nodes (1, 11). Each node (1, 11) includes a first, active or working, line termination board (2) terminating said first transmission line (6), a second, passive or standby, line termination board (3) terminating said second transmission line (8). Each node also includes a node core (4) with a link supervision block (10). The line termination boards (2, 3) are adapted to report faults to the link supervision block (10), whereupon the node core (4) will switch traffic between the line termination boards (2, 3). In a preferred embodiment of the invention both line termination boards (2, 3) are adapted to report fault state changes spontaneously when they are detected to the link supervision block (10), the link supervision block (10) is adapted to store received fault causes and correlate the latest received fault causes from each line termination board (2, 3) with the latest received fault cause from the other line termination board (2, 3), the system further including a persistency timer adapted to be started by the link supervision block (10) in order to supervise the persistence of a correlation result, if the correlation result has not disappeared during a persistency timer period, the link supervision block (10) is adapted to request the node core (4) to switch traffic between the line termination boards (2, 3).



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Systems for Protection Link Supervision

Technical Field

The present invention relates to a system of performing protection link fault supervision in a Synchronous Digital Hierarchical (SDH) based network. The principles of the SDH protocol are described in International Telecommunication Union recommendation ITU G.707.

Technical Background

To connect Radio Network Controller nodes to form a Radio Access Network, there is a need to protect the physical lines connecting these nodes against failure. A common architecture to achieve line protection in an SDH based network uses two physical lines to connect two nodes of the network. The node that is sending the data traffic, sends the data on two lines to the receiving node. If one of the lines breaks, the receiving node can extract the traffic from the other line.

The RNC node includes two line termination boards, of which one is active and the other is in standby mode. A link supervision block supervises the function of the lines and termination boards, and performs a switchover from the active to the standby board should a fault occur on one of the connections.

In the AXE system manufactured by Telefonaktiebolaget LM Ericsson such a supervision system is implemented. Faults detected on the active board are sent towards the supervision block spontaneously when they are detected. The supervision block then reads out state information from the standby board. The results are correlated to achieve information about a fault cause (failure in the active board or the connected line, failure in the standby board

or the connected line, failure in the internal link between the boards, no failure).

Such a system is prone to some problems:

We can imagine that an identical fault is detected on both
5 boards. Due to varying detection and signal transmission
times, it is undetermined which fault (i.e. from which
board) that will be reported first. Then the correlation
result might not reflect the true physical situation, and
the supervision block may misunderstand the situation.
10 Varying detection times is caused by the standby board not
reporting faults immediately, but instead checks the
situation at fixed time intervals.

Even a single short disturbance can lead to a failure being
reported without being justified.

15 In addition, the active and standby boards have two rather
different functions. In case of failure, the functions must
be swapped, without losing information on the faults that
has occurred. This might be complicated to implement in a
computer program.

20 **Summary of the invention**

It is an object of the present invention to provide a
supervision system for protecting transmission paths in
radio access networks, which is more reliable in deciding
the true cause of a fault.

25 Another object of the invention is to provide a system that
is nearly immune against random disturbances.

Still another object is to provide a system that is less
costly to implement than prior art systems.

These and other objects are achieved in a system as defined in the appended patent claims.

Brief description of the drawings

The invention will now be described in detail in reference
5 to the appended drawings, in which

Fig. 1 gives a schematic overview of the circuitry used in current radio access network nodes in order to protect against line faults,

Fig. 2 is a sequence diagram showing the detection of a
10 fault in the system outlined in Fig. 1 (prior art),

Fig. 3 shows a similar diagram and the detection of faults in a system according to the present invention.

Detailed description of the invention

Fig. 1 shows two radio access network nodes, 11 and 1, with
15 redundant lines, 6 and 8, between the nodes for securing a reliable connection between them.

The node 1 has an active Line Termination Board 2 that carries the data traffic, a passive Line Termination Board 3 that can be used as a replacement and a Node Core 4 that
20 switches the data traffic and contains a Link Supervision instance 10.

The incoming data traffic is sent from a source node 11. The data source 5a sends via link 6 towards the active board 2. The same data traffic is sent by the data source
25 5b via link 8 to the passive board 3 and further via the internal link 9 to the active board 2 that selects one of the two external links as an input and sends the data further via internal link 7 towards the core 4.

In normal operation the active board 2 has the role of the working board, it takes the data traffic from link 6. Board 3 has the role of the standby board, it forwards the incoming traffic to the active board.

- 5 When link 6 becomes unusable, the data traffic is taken from internal link 9 (protected operation). The Link Supervision Block 10 controls the switch between these two modes. The roles of the boards are swapped.

10 Essential for the usability of the protected operation mode is the absence of faults that might disturb data traffic on internal link 9. Therefore the supervision block 10 needs information about the transmitter state from board 3 and about the receiver state from board 2. Information from both boards is needed to be able to decide about the cause
15 of a possible fault to determine if a switch is possible or needed.

As explained earlier, faults detected on the working board 2 will be sent towards the supervision block 10 spontaneously when they are detected. The supervision block
20 then reads out the state information from the standby board 3. The results are correlated to achieve information about a fault cause (failure in board 2, failure in board 3, link failure, no failure).

In one instance one class of faults is detected on both
25 boards. Due to varying detection and signal transmission times, it is not determined which fault will be reported first $\{t_3 < t_2\}$ or $\{t_3 > t_2\}$. It is possible that the fault on board 3 is detected after the information was read out $\{t_3 - t_r > 0\}$. Then the correlation result at $\{t_f\}$ does not
30 reflect the physical situation.

Varying detection times can e.g. be caused by checks that are triggered by expiry of a fixed-period timer. Since

these faults can not be detected between the checks, the detection time may vary from 0 up to a time period.

The correlation result is not checked for persistency in a defined period. This might lead to unjustified failure from
5 the supervision block towards an operator in case of a single short disturbance.

The implementation of this method as a software program is expensive because the two different roles of the board imply different reactions upon fault detection. Only the
10 working one reports spontaneously, the functionality to switch between the two roles must be implemented in a way that secures that knowledge on initial faults of the standby board are preserved.

Fig. 3 shows the timing diagram for a system according to
15 the invention. The hardware is as described in Fig. 1. However, several new functions are implemented in the line boards 2,3 and the supervision block 10.

According to a first embodiment of the invention, the following actions are performed when each of the boards 2,3
20 detect a fault state change:

Both boards report all fault state changes spontaneously when they are detected to the supervision block.

The supervision block stores the received faults causes.

The received fault cause is correlated with the latest
25 received fault cause of the board terminating the other end of the link.

A timer is started to supervise the persistency of the correlation result.

When the result has not disappeared during the persistency timer period, it can be reported.

If the correlation result shows that a traffic-disturbing fault on the link has occurred and that the traffic can be
5 reestablished by some actions is the node, e.g. re-routing, then these actions can be started.

One advantage of this system is that the result of the supervision block is as accurate as possible since all fault changes are reported immediately after detection.
10 This overcomes the timing problems of the known solution.

The persistency check ensures that the correlation result is correct and stable.

The timeout can be selected to fulfill system requirements for a specified detection time.

15 The timeout can be selected to suppress short time disturbances.

The method is inexpensive and can thereby easily be implemented as a computer program because the fault detection mechanism in both boards is independent of the
20 board's role (working/standby).

In an alternative embodiment of the invention an additional persistency check is implemented before the correlation is done. If this check is done by the reporting board, the amount of signaling towards the supervision block can be
25 reduced in case of faults that change state with a high frequency. With this pre-correlation check, the persistency check after correlation could be left out under certain circumstances.

While the present invention has been described in relation
30 to SDH based networks, the applicability is not restricted

to this particular type of network. All transmission techniques can be used that support error detection. Thus, this system can be used for general link supervision, when information about the sender of data traffic as well as
5 information about the receiver of data traffic is available at different locations and needs to be correlated to gain information about the state of the link.

Patent claims

1. System for protection link fault supervision between two nodes (1, 11) in a transmission network, the nodes (1, 11) being connected by first (6) and second (8) transmission lines carrying identical data traffic between the nodes (1, 11), each node (1, 11) including a first, active or working, line termination board (2) terminating said first transmission line (6), a second, passive or standby, line termination board (3) terminating said second transmission line (8), and a node core (4) including a link supervision block (10), said line termination boards (2, 3) being adapted to report faults to the link supervision block (10), said node core (4) being adapted to switch traffic between the line termination boards (2, 3) in case of a fault, characterized in that both line termination boards (2, 3) are adapted to report fault state changes spontaneously when they are detected to the link supervision block (10), the link supervision block (10) is adapted to store received fault causes and correlate the latest received fault causes from each line termination board (2, 3) with the latest received fault cause from the other line termination board (2, 3), the system further including a persistency timer adapted to be started by the link supervision block (10) in order to supervise the persistence of a correlation result, if the correlation result has not disappeared during a persistency timer period, the link supervision block (10) is adapted to request the node core (4) to switch traffic between the line termination boards (2, 3).
2. System as claimed in claim 1, characterized in that each line termination board (2, 3) includes an additional persistency timer, when a fault is detected in one of the boards (2, 3) the

board is adapted to start its additional persistency timer in order to supervise the persistence of the detected fault,

if the fault has not disappeared during a persistency timer period, the line termination board is adapted to report the fault to the link supervision block (10).

3. System as claimed in claim 1 or 2, characterized in that said transmission network is a Synchronous Digital Hierarchical based network.

4. System for protection link fault supervision between two nodes (1, 11) in a transmission network, the nodes (1, 11) being connected by first (6) and second (8) transmission lines carrying identical data traffic between the nodes (1, 11), each node (1, 11) including a first, active or working, line termination board (2) terminating said first transmission line (6), a second, passive or standby, line termination board (3) terminating said second transmission line (8), and a node core (4) including a link supervision block (10), said line termination boards (2, 3) being adapted to report faults to the link supervision block (10), said node core (4) being adapted to switch traffic between the line termination boards (2, 3) in case of a fault,

characterized in that each line termination board (2, 3) includes a persistency timer,

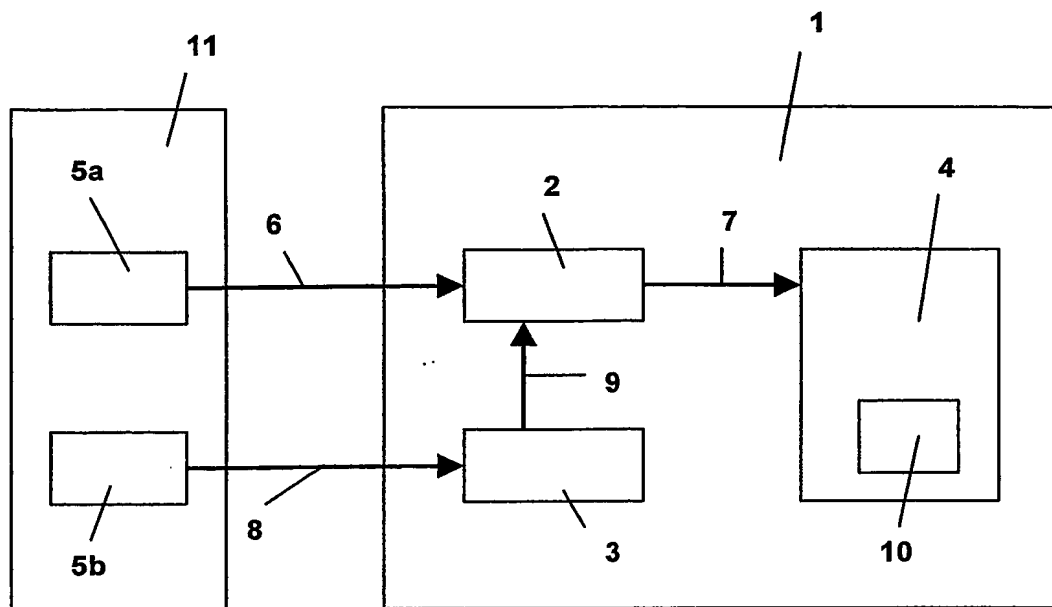
when a fault is detected in one of the line termination boards (2, 3) the line termination board is adapted to start its persistency timer in order to supervise the persistence of the detected fault,

if the fault has not disappeared during a persistency timer period, the line termination board is adapted to immediately report the fault to the link supervision block (10),

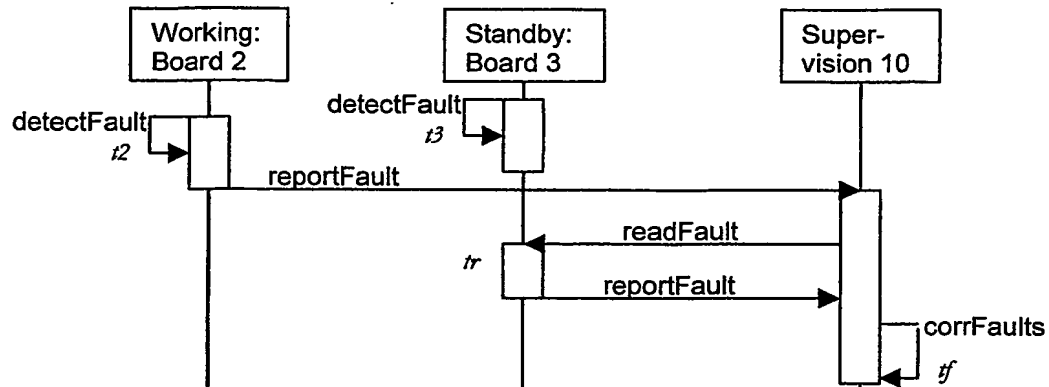
the link supervision block (10) being adapted to store received fault causes and correlate the latest received

fault causes from each board with the latest received fault
cause from the other board,
if the link supervision block (10) decides that a fault has
occurred, it is adapted to request the node core (4) to
5 switch traffic between the line termination boards (2, 3).

5. System as claimed in claim 4,
c h a r a c t e r i z e d i n that said transmission
network is a Synchronous Digital Hierarchical network.

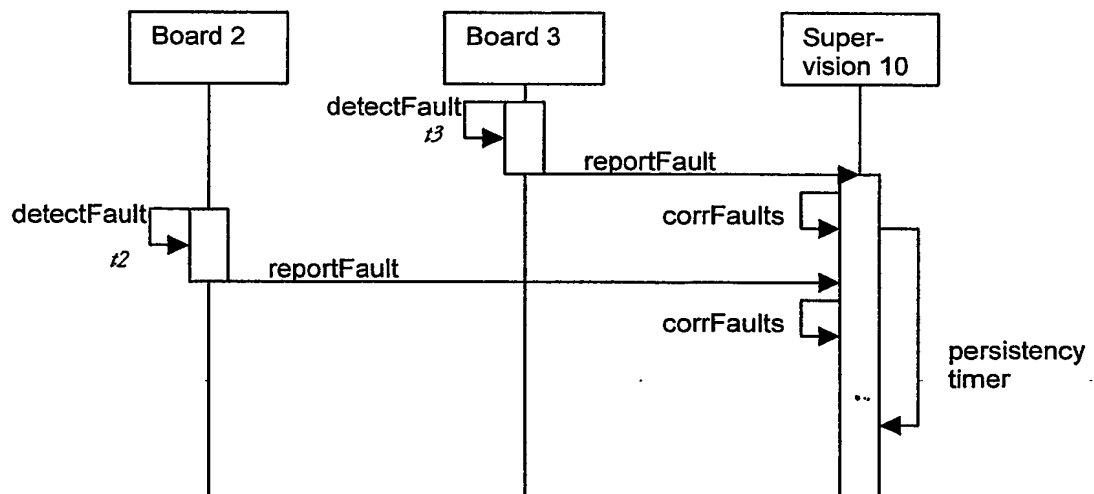
1 / 2*fig. 1*

2 / 2



Note: *t2*, *t3*, *tr* and *tf* are event IDs to be referred by timing analysis.

fig. 2



Note: *t2*, *t3* and *tf* are event IDs to be referred by timing analysis.

fig. 3

INTERNATIONAL SEARCH REPORT

Inter application No
NO 02/00318

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B1/74

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WHITE PAPER: "Automatic Protection Switching on the CBX 500 and GX 550 Multoservice WAN Switches" LUCENT TECHNOLOGIES, INC., August 2001 (2001-08), XP002239095 page 4, line 42 -page 5, line 8 ---	1-5
A	US 6 294 991 B1 (BENGSTON LEE ET AL) 25 September 2001 (2001-09-25) column 2, line 28 - line 63 abstract ---	1-5
A	EP 0 824 292 A (LUCENT TECHNOLOGIES INC) 18 February 1998 (1998-02-18) page 4, line 29 - line 39 page 5, line 13 - line 53 abstract --- -/--	1-5

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

23 April 2003

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INTERNATIONAL SEARCH REPORT

Int. Application No
NO 02/00318

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>ACHIM AUTENRIETH ET AL: "Evaluation of multi-layer recovery strategies" EUNICE'98 - OPEN EUROPEAN SUMMER SCHOOL, MUNICH, GERMANY, September 1998 (1998-09), XP002239096 paragraph [03.2] paragraph [04.2] - paragraph [04.3] -----</p>	1-5

INTERNATIONAL SEARCH REPORT

Int.

Application No

NU 02/00318

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EP 0824292	A	18-02-1998	US 5838924 A 17-11-1998
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		EP 0824292 A2	18-02-1998
		JP 10084362 A	31-03-1998